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| EXAMINER | |
|---|---|
| MALDONADO, JULIO J | |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/820,525 | WU ET AL. | |
| | Examiner | Art Unit | |
| | Julio J. Maldonado | 2823 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will epply end will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *26 July 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-10,12-31,34 and 35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-10,12-31,34 and 35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *07 April 2007* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *07/26/2007*.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *200709251* .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

1. The rejection as set forth in the office action mailed 03/28/2007 is withdrawn in view of the applicants' amendments.

2. The cancellation of claim 11 is acknowledged.

3. Claims 1-10 and 12-33 are pending in the application.

### *Continued Examination Under 37 CFR 1.114*

4. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 07/26/2007 has been entered.

## EXAMINER'S AMENDMENT

5. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Denise Bergin (Reg. No. 50,581) on 09/24/2007. On a telephone interview with the attorney of record, Denise Bergin, the examiner pointed out that claims 32 and 33 were improperly amended under CFR §1.121. The examiner suggested the attorney of

record, under the examiner's supervisor's recommendation, to cancel claims 32 and 33, and add newly claims 34 and 35.

The attorney of record, Denise Bergin authorized the cancellation of claims.

The application has been amended as follows:

In the claims:

Cancel claims 32 and 33.

Add new claims:

34. (New) The method of claim 1 wherein the deposited carbon doped oxide layer is an interlayer dielectric (ILD) in a partially or fully fabricated semiconductor device.

35. (New) The method of claim 1 the wherein the deposited carbon doped oxide layer has a carbon-carbon triple bond to silicon oxide bond ratio of about 0.05% to 20% based on FTIR peak area.

***Drawings***

6. Figure 1a, 1b and 2 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

7. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: in page 9, paragraph [0038], applicants make reference to characters '200', '202', '204' and '206' in Figure 3. However said reference characters are not included in said Figure 3. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

8. The drawings are also objected to because the disclosed specification makes reference to Figure 7C. However, such Figure is not included in the drawings. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes

made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Specification***

9. Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

10. The disclosure is objected to because of the following informalities: in page 29, paragraph [00119], where applicants recite "...1010...", change to --1410--.

Appropriate correction is required.

11. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: Methods for producing low-k carbon doped films with low residual stress.

***Claim Rejections - 35 USC § 103***

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. Claims 1, 2, 6-9, 14-16, 18-20, 22-28, 31 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hyodo et al. (U.S. 7,064,088 B2, hereinafter Hyodo) in view of the following arguments.

In reference to claims 1, 19, 24 and 34, Hyodo teaches a method of forming a low-k dielectric layer to reduce capacitance in multi layered wiring structures (Hyodo, column 1, lines 29 – 37) including the steps of providing a substrate in a deposition chamber (Hyodo, column 11, lines 2 – 5); providing a precursor to the deposition chamber (Hyodo, column 4, lines 9 – 12); igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components (Hyodo, column 13, lines 13 – 19), wherein about 1%-50% percent of total radio frequency power is provided by the low frequency component (Hyodo, column 13, lines 29 – 32), which has a frequency of between about 2 MHz or less (Hyodo, column 13, lines 32 – 33); and depositing the low-k dielectric layer (Hyodo, column 4, lines 13 – 17) under conditions in which the dielectric layer has a stress labeled residual tensile or compressive stress of about 0 to about 300 MPa and wherein

the dielectric constant of the carbon doped oxide dielectric laver is less than 4 (Hyodo, column 14, lines 65 – 67).

Hyodo fails to expressly disclose wherein at least about 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100kHz and 600kHz, wherein the dielectric layer has a compressive stress less than about 50 MPa and wherein the dielectric constant is not greater than 3.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping low frequency, stress and dielectric constant to arrive at the claimed invention.

Still, Hyodo fails to expressly disclose wherein said low-k dielectric layer is a carbon doped oxide dielectric layer.

However, Hyodo teaches wherein said precursor comprises a silicon-containing hydrocarbon compounds having the general formula $Si_\alpha O_\beta C_\chi H_\gamma$, wherein $\alpha$, $\beta$, $\chi$ and $\gamma$ are integers (Hyodo, column 4, lines 35 – 36), wherein said silicon containing hydrocarbon comprises cyclic compounds having c=c bonds (i.e., unsaturated) (Hyodo, column 5, line 15 – column 6, line 20), linear compounds having c=c bonds (i.e., unsaturated) (Hyodo, column 6, line 29 – column 8, line 40). Furthermore, Hyodo teaches wherein said precursor further includes an additive gas such as ethene ($C_2H_4$)

(Hyodo, column 13, lines 51 – 67) and a carrier gas selected from the group consisting of $N_2$, He, Ne and Ar (Hyodo, column 13, lines 41 – 42).

Having this in mind, the disclosed specification teaches wherein the precursors comprise silanes, alkylsilanes, alkoxysilanes, and cyclic siloxanes (page 12, paragraph [0047]) and small molecules having 2 to 6 carbon atoms and one or more carbon-carbon double bonds or carbon-carbon triple bonds (page 14, paragraph [0068]).

Therefore, in light of the specification, the precursors of Hyodo are labeled carbon doped precursors and the dielectric layer of Hyodo is labeled a carbon doped dielectric layer.

Therefore, Hyodo teaches the same materials (i.e., unsaturated silicon-containing hydrocarbon precursors) and said materials are treated the same way (i.e., plasma deposition process at overlapping conditions), the low-k dielectric layer is labeled carbon doped oxide dielectric layer.

In reference to claims 2 and 20, Hyodo teaches wherein the radio frequency power has a high frequency component in the range of greater than 2 MHz (Hyodo, column 13, lines 35 – 36).

Hyodo fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric

layer at the overlapping low frequency and having the overlapping stress and dielectric constant to arrive at the claimed invention.

In reference to claims 6 and 22, Hyodo teaches wherein the substrate is maintained at a temperature of between about 350°C to 450°C (Hyodo, column 12, lines 3 – 5).

Hyodo fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 425 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping temperature to arrive at the claimed invention.

In reference to claim 7, Hyodo teaches wherein the substrate is maintained at a temperature of between about 350°C to 450°C (Hyodo, column 12, lines 3 – 5).

Hyodo fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 400 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping temperature to arrive at the claimed invention.

In reference to claims 8 and 23, Hyodo teach wherein the deposition chamber is maintained at a pressure of between about 1-10 Torr (Hyodo, column 9, lines 35 – 36).

Hyodo fails to expressly disclose wherein the deposition chamber is maintained at a pressure of between about 2 and 20 Torr during deposition of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping pressure to arrive at the claimed invention.

In reference to claim 9, Hyodo teach wherein the deposition chamber is maintained at a pressure of between about 1-10 Torr (Hyodo, column 9, lines 35 – 36).

Hyodo fails to expressly disclose wherein the deposition chamber is maintained at a pressure of between about 2 and 10 Torr during deposition of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping pressure to arrive at the claimed invention.

In reference to claims 14 and 25, Hyodo teaches wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor (Hyodo, column 11, lines 1 – 17).

In reference to claims 15 and 26, the Hyodo teaches wherein a separation gap between the showerhead and the block is maintained at a distance of 24 mm (Hyodo, column 15, lines 8 – 9).

Hyodo fails to expressly disclose wherein a separation gap between the showerhead and the block is maintained at a distance between about 5 mm and 100 mm.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping separation gap to arrive at the claimed invention.

In reference to claims 16 and 27, Hyodo teaches wherein the carbon doped oxide precursor is selected from the group consisting of alkylsilanes, alkoxysilanes, linear siloxanes and cyclic siloxanes (Hyodo, column 5, line 15 – column 8, line 40).

In reference to claim 18, Hyodo teaches wherein the carbon doped oxide precursor is a compound having a carbon-carbon double bond (Hyodo, column 5, line 15 – column 8, line 40).

In reference to claim 28, Hyodo teaches wherein the substrate is maintained at a temperature of between about 350°C to 450°C (Hyodo, column 12, lines 3 – 5).

Hyodo fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 350 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping temperature to arrive at the claimed invention.

In reference to claim 31, Hyodo teaches providing a substrate to a deposition chamber (Hyodo, column 11, lines 2 – 5); providing a precursor to the deposition chamber (Hyodo, column 4, lines 9 – 12), wherein the precursor comprises a molecule having at least one carbon-carbon double bond (Hyodo, column 5, line 15 – column 6, line 20 and column 6, line 29 – column 8, line 40); igniting and maintaining a plasma in a deposition chamber using high frequency radio frequency power greater than 2 MHz (Hyodo, column 13, lines 35 – 36); and depositing the carbon doped dielectric layer while the deposition chamber is maintained at a pressure of between about 1-10 Torr (Hyodo, column 9, lines 35 – 36), wherein the carbon doped oxide dielectric layer has a

residual compressive stress of magnitude of about 0 to about 300 MPa and wherein the dielectric constant of the carbon doped oxide dielectric laver is less than 4 (Hyodo, column 14, lines 65 – 67), and wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor (Hyodo, column 11, lines 1 – 17), with a separation distance of about 24 mm between the showerhead and the block (Hyodo, column 15, lines 8 – 9).

Hyodo fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz, wherein the deposition chamber is maintained at a pressure between about 2 and 20 Torr, wherein the carbon doped oxide dielectric layer has a residual tensile or compressive stress of magnitude less and about 50 MPs and a dielectric constant of less than 3, and wherein the separation distance is about 5 mm to 100 mm between the showerhead and the block.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Hyodo to form a dielectric layer at the overlapping low frequency and separation gap to obtain a dielectric layer with overlapping stress and dielectric constant to arrive at the claimed invention.

14. Claims 1-16, 19-32 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (U.S. 2005/0156285 A1, hereinafter Gates).

In reference to claims 1 and 19, Gates (Figs.4-7) teaches a method of forming a low-k dielectric layer including the steps of providing a substrate to a deposition chamber (Gates, [0079]); providing an unsaturated precursor to the deposition chamber; igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components (Gates, [0080] – [0081]); and depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile stress of magnitude of less than 45 MPa and a dielectric constant of about 2.8 or less (Gates, [0045]); and forming conductive lines in the dielectric layer (Gates, [0113]).

Gates fails to expressly disclose wherein the dielectric layer has a tensile stress less than about 50 MPa and wherein the dielectric constant is not greater than 3.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Gates to form a dielectric layer having the overlapping stress and dielectric constant to arrive at the claimed invention.

Gates fails to expressly disclose wherein said low-k dielectric layer is a carbon doped dielectric layer and wherein said precursor is a carbon doped precursor. However, Gates teaches wherein the low-k dielectric layer has the general formula

SiCOH having 10-20 atomic % of Si, 10-30 atomic % of C, 10-35 atomic % of O and 20-45 atomic % of H (Gates, [0041]), and wherein said precursor gas comprises organic molecules with ring structures such as cyclic siloxanes, silanes and the like (Gates, [0061]) and unsaturated organic compounds containing unsaturated C=C double bonds (Gates, [0062]).

Having this in mind, the disclosed specification teaches wherein the precursors comprise silanes, alkylsilanes, alkoxysilanes, and cyclic siloxanes (page 12, paragraph [0047]) and small molecules having 2 to 6 carbon atoms and one or more carbon-carbon double bonds or carbon-carbon triple bonds (page 14, paragraph [0068]).

Therefore, in light of the specification, the precursors of Gates are labeled carbon doped precursors and the dielectric layer of Gates is labeled a carbon doped dielectric layer.

Furthermore, Gates teaches wherein the low frequency has a power of less than 250 W (Gates, [0074]). Gates fails to disclose wherein at least 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100 kHz and 600kHz. However, the selection of the claimed frequency is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). See MPEP 2144.05, II A.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to arrive at the claimed limitations through routinary experimentation.

In reference to claims 2 and 20, Gate teaches wherein the radio frequency power has a high frequency component in the range of between 0.45 MHz to 200 MHz (Gates, [0063]).

Gates fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process disclosed in Gates at the overlapping high frequency to arrive at the claimed invention.

In reference to claim 3, Gates teaches wherein the low frequency component of the radio frequency power has a power of between about 0.1 and 1.0 Watts/$cm^2$ of substrate surface area (Gates, [0074]).

Gates fails to expressly disclose wherein the low frequency component of the radio frequency power has a power of between about 0.02 and 20 Watts/$cm^2$ of substrate surface area.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the

invention was made to enable using the process of Gates at the overlapping low frequency power to arrive at the claimed invention.

In reference to claims 4, 5 and 21, Gates teaches wherein the carbon doped oxide layer is formed by pulsed plasma enhanced chemical vapor deposition (Gates, [0058]).

Gates fails to disclose pulsing the high frequency component of the radio frequency power delivered to the chamber at a frequency of between about 500 Hz and 10 kHz during deposition and wherein the pulsing has a duty cycle of between about 20 and 80%.

However, the selection of the claimed specification is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). See MPEP 2144.05, II A.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to arrive at the claimed limitations through routinary experimentation.

In reference to claims 6 and 22, Gates teaches wherein the substrate is maintained at a temperature of between about 300°C to 450°C (Gates, [0072]).

Gates fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 425 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping temperature range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claim 7, Gates teaches wherein the substrate is maintained at a temperature of between about 300°C to 450°C (Gates, [0072]).

Gates fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 400 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping temperature range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claims 8 and 23, Hyodo teach wherein the deposition chamber is maintained at a pressure of between about 1-7 Torr (Gates, [0065]).

Gates fails to expressly disclose wherein the deposition chamber is maintained at a pressure of between about 2 and 20 Torr during deposition of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping pressure range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claim 9, Gates teach wherein the deposition chamber is maintained at a pressure of between about 1-7 Torr (Gates, [0065]).

Gates fails to expressly disclose wherein the deposition chamber is maintained at a pressure of between about 2 and 10 Torr during deposition of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping pressure range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claim 10, Gates teaches wherein the residual tensile stress of the carbon doped oxide dielectric layer is of less than 45 MPa (Gates, [0045]).

Gates fails to disclose wherein the residual tensile stress of the carbon doped dielectric layer is at most about 35 MPa.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping stress range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claims 12 and 24, Gates teaches wherein the carbon doped dielectric layer has a dielectric constant of 2.8 or less and wherein residual tensile stress of the carbon doped oxide dielectric layer is of less than 45 MPa (Gates, [0045]).

Gates fails to disclose wherein the residual tensile stress of the carbon doped dielectric layer is less than about 30 MPa.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping stress range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claim 13, Gates teaches wherein the carbon doped oxide dielectric layer has a modulus from about 2 Gpa to about 15 GPa (Gates, [0045]).

Gates fails to expressly disclose wherein the carbon doped oxide dielectric layer has a modulus of at least about 3 Gpa.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping elastic modulus range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claims 14 and 25, Gates teaches wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor (Gates, [0063]).

In reference to claims 15 and 26, the Gates teaches wherein a separation gap between the showerhead and the block is maintained at a distance of 10 to 120 mm (Gates, [0063]).

Gates fails to expressly disclose wherein a separation gap between the showerhead and the block is maintained at a distance between about 5 mm and 100 mm.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping pressure range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claims 16 and 27, Gates teaches wherein said precursor gas comprises organic molecules with ring structures such as cyclic siloxanes, silanes and the like (Gates, [0061]) and unsaturated organic compounds containing unsaturated C=C double bonds (Gates, [0062]).

In reference to claim 28, Gates teaches wherein the substrate is maintained at a temperature of between about 350°C to 450°C (Gates, [0072]).

Gates fails to expressly disclose wherein the substrate is maintained at a temperature of between about 300 and 350 degrees C during depositing of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping temperature range in the process disclosed in Gates to arrive at the claimed invention.

In reference to claims 29 and 30 Gates (Figs.4-7) teaches providing a substrate to a deposition chamber (Gates, [0079]); providing an unsaturated precursor to the deposition chamber; igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components (Gates, [0080] – [0081]); and depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile stress of magnitude of less than 45 MPa and a dielectric constant of about 2.8 or less (Gates, [0045]), wherein the radio frequency power has a high frequency component in the range of between 0.45 MHz to 200 MHz (Gates, [0063]), wherein the low frequency component of the radio frequency power has a power of between about 0.1 and 1.0 Watts/$cm^2$ of substrate surface area (Gates, [0074]), and wherein the carbon doped oxide layer is formed by pulsed plasma

enhanced chemical vapor deposition (Gates, [0058]); and forming conductive lines in the dielectric layer (Gates, [0113]).

Gates fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz; wherein the carbon doped dielectric layer has a residual tensile stress of less than about 50 MPa and wherein the dielectric constant is less than about 3.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping frequency, stress and dielectric constant according to the process of Gates to arrive at the claimed invention.

Gates fails to disclose pulsing the high frequency component of the radio frequency power delivered to the chamber at a frequency of between about 500 Hz and 10 kHz during deposition and wherein the pulsing has a duty cycle of between about 20 and 80%.

However, the selection of the claimed specification is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). See MPEP 2144.05, II A.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to arrive at the claimed limitations through routinary experimentation.

In reference to claim 31, Gates teaches providing a substrate to a deposition chamber (Gates, [0079]); providing an unsaturated precursor to the deposition chamber; igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components (Gates, [0080] – [0081]); and depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile stress of magnitude of less than 45 MPa and a dielectric constant of about 2.8 or less (Gates, [0045]); wherein the radio frequency power has a high frequency component in the range of between 0.45 MHz to 200 MHz (Gates, [0063]), wherein the low frequency component of the radio frequency power has a power of between about 0.1 and 1.0 Watts/$cm^2$ of substrate surface area (Gates, [0074]), wherein the carbon doped oxide layer is formed by pulsed plasma enhanced chemical vapor deposition (Gates, [0058]), wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor (Gates, [0063]), wherein the deposition chamber is maintained at a pressure of between about 1-7 Torr (Gates, [0065]), and wherein a separation gap between the showerhead and the block is maintained at a distance of 10 to 120 mm (Gates, [0063]); and forming conductive lines in the dielectric layer (Gates, [0113]).

Gates fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz; wherein the carbon doped dielectric layer has a residual tensile stress of less than about 50 MPa, wherein the dielectric constant is less than about 3, wherein the chamber is maintained at a pressure of about 2 to 20 Torr, and wherein a separation gap between the showerhead and the block is maintained at a distance between about 5 mm and 100 mm.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the overlapping deposition conditions in the process disclosed in Gates to arrive at the claimed invention.

In reference to claim 34, Gates teaches wherein the deposited carbon doped oxide layer is an interlayer dielectric (ILD) in a semiconductor device (Gates, [0113] – [0114]).

15. Claims 17 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hyodo ('088) as applied to claims 1, 2, 6-9, 14-16, 18-20, 22-28, 31 and 34 above, and further in view of Rhee et al. (U.S. 7,087,271 A1, hereinafter Rhee).

Hyodo substantially teaches all aspects of the invention including wherein the carbon doped oxide precursor has the general formula $Si_\alpha O_{\alpha-1} R_{2\alpha-\beta+2}(OR')_\beta$, wherein $\alpha$ is an integer of 1-3, $\beta$ can be 0 and R is $C_{1-6}$ hydrocarbon attached to Si and R' is $C_{1-6}$ unattached to Si. Hyodo fails to disclose wherein the carbon doped oxide precursor is

ethynyltrimethylsilane. However, Rhee teaches a related method to form low dielectric constant layers teaches providing a substrate in a CVD chamber; introducing carbon doped oxide precursor into the chamber; and depositing said low-k dielectric layer, wherein said carbon doped oxide precursor is selected from a group including ethynyltrimethylsilane (Rhee, column 3, lines 38 – 52). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Hyodo and Rhee to enable depositing the low-k dielectric layer of Hyodo using the precursor according to the teachings of Rhee because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of forming the disclosed low-k dielectric layer of Hyodo and art recognized suitability for an intended purpose has been recognized to be motivation to combine (MPEP 2144.07), and furthermore, because this would result in dielectric layer with dielectric constant of less than 2.6 (Rhee, column 1, lines 56 – 60).

Still, the combination of Hyodo and Rhee fail to expressly disclose wherein the deposited carbon doped dielectric layer has a carbon-carbon triple bond to silicon oxide bond ratio of about 0.05% to 20% based on FTIR pear area. However, the combination of Hyodo and Rhee teach wherein one of the reactants used is ethynyltrimethylsilane (Rhee, column 3, lines 38 – 52), which is a silicon containing compound having a carbon-carbon triple bond. Furthermore, the same materials are treated the same way and therefore, the same results would be obtained. Accordingly, the combination of Hyodo and Rhee teach upon the claimed invention.

***Double Patenting***

16. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

17. Claims 1, 2, 8-10, 12, 13 and 16-18 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 18, 11, 17 and 30 of copending Application No. 10/941,502. Although the conflicting claims are not identical, they are not patentably distinct from each other because of the following reasons.

In reference to claim 1, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claims 1 and 17 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate, the method comprising providing the substrate to a deposition chamber (claim 1, line 3); providing an carbon doped oxide

precursor to the deposition chamber, wherein said carbon doped oxide precursors have carbon-carbon triple bonds (claim1, lines 4 – 7); igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components (claim 1, lines 8 – 9, claim 8 lines 1 – 2 and claim 17, lines 1 - 4), wherein the low frequency is between about 100 kHz to 600 kHz and having a power of 50 W to 2000 W and wherein the high frequency is about 14 MHz and having a power of 100 W to 3000 W (claim 17, lines 1 – 4); and depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile or compressive stress of magnitude between about –20 to 30 MPa and wherein the dielectric constant of the carbon doped oxide dielectric laver is between about 2.5-3.0 (claim 1, lines 5 – 12).

The scope of 10/941,502 fails to expressly disclose wherein said carbon doped oxide precursor is unsaturated. However, 10/941,502 teaches providing an carbon doped oxide precursor to the deposition chamber, wherein said carbon doped oxide precursors have carbon-carbon triple bonds (claim1, lines 4 – 7), which are unsaturated. Therefore the scope of 10/941,502 teaches on the claimed limitation.

However, the scope of 10/941,502 fails to expressly disclose wherein at least about 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100kHz and 600kHz and wherein in which the dielectric layer has a residual tensile or compressive stress of magnitude less than about 50MPa and wherein the dielectric constant of the carbon doped oxide dielectric laver is not greater than about 3.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric having the overlapping stress and the overlapping dielectric constant at the overlapping deposition conditions to arrive at the claimed invention.

In reference to claim 2, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claims 1 and 17 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the high frequency is about 14 MHz (claim 17, lines 1 – 4).

However, the scope of 10/941,502 fails to expressly disclose wherein the radio frequency power has a high frequency component in the range of between about 2 MHz and 60 MHz.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric at the overlapping deposition conditions to arrive at the claimed invention.

In reference to claims 8 and 9, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claim 32 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the deposition pressure is maintained at a pressure of between about 0.1 Torr to 20 Torr (Claim 32, lines 1 – 2).

However, the scope of 10/941,502 fails to expressly disclose wherein the deposition chamber is maintained at a pressure of between about 2 and 20 Torr during deposition of the carbon doped oxide dielectric layer.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric at the overlapping deposition conditions to arrive at the claimed invention.

In reference to claim 10, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claim 1 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the residual stress is between about –20 to 30 MPa (claim 1, lines 11 – 12).

However, the scope of 10/941,502 fails to expressly disclose wherein the residual tensile stress of the carbon doped oxide dielectric layer is at most about 35 MPa.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric having the overlapping stress to arrive at the claimed invention.

In reference to claim 12, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claim 1 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the residual stress is between about –20 to 30 MPa and wherein the dielectric constant is between 2.5-3.0 (claim 1, lines 11 – 12).

However, the scope of 10/941,502 fails to expressly disclose wherein the residual tensile stress of the carbon doped oxide dielectric layer is at most about 30 MPa and wherein the dielectric constant is no greater than 2.8.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric having the overlapping stress and dielectric constant to arrive at the claimed invention.

In reference to claim 13, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claim 30 of Application

No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the elastic modulus is not less than about 6 GPa.

However, the scope of 10/941,502 fails to expressly disclose wherein the elastic modulus is at least about 3GPa.

However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to enable using the process of Application No. 10/941,502 to from a carbon doped oxide dielectric having the overlapping elastic modulus to arrive at the claimed invention.

In reference to claims 16-18, the scope of the claimed limitation of the instant application is essentially the same as the claimed limitations of claim 11 of Application No. 10/941,502. The limitations include a method of preparing a carbon doped silicon oxide (CDO) film on a substrate wherein the precursor is selected from the group consisting of Ethynyltrimethylsilane (ETMS), Bis(trimethylsilyl)acetylene (BTMSA), dimethylmethoxysilaneacetylene (DMMOSA) and dimethylsilane-diacetylene (DMSDA) (Claim 11, lines 1 – 4).

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

***Response to Arguments***

18. Applicant's arguments filed 07/26/2007 have been fully considered but they are not persuasive.

Applicants argue, "...even without regard to the question of whether the deposited films are oxides or carbides, neither Hyodo nor any cited reference teaches or suggests deposition of a film having both a dielectric constant of 3.0 or less and a stress of less than 50 MPa in magnitude...".

In response to this argument, as stated hereinabove, Hyodo teaches wherein the dielectric layer residual compressive stress of about 0 to about 300 MPa and wherein the dielectric constant of the carbon doped oxide dielectric laver is less than 4 (Hyodo, column 14, lines 65 – 67). Hyodo fails to expressly disclose wherein the dielectric layer has a compressive stress less than about 50 MPa and wherein the dielectric constant is not greater than 3. However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the process disclosed in Hyodo to achieve a dielectric layer having the claimed stress and dielectric constant to arrive at the claimed invention.

***Conclusion***

19. Applicants are encouraged, where appropriate, to check Patent Application Information Retrieval (PAIR) (http://portal.uspto.gov/external/portal/pair) which provides

applicants direct secure access to their own patent application status information, as well as to general patent information publicly available.

20. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

21. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for this group is 571-273-8300. Updates can be found at http://www.uspto.gov/web/info/2800.htm.

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Patent Examiner
Art Unit 2823

JJM
September 25, 2007